PRINTER RUSH
(PTO ASSISTANCE)

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[RUSH] **MESSAGE:** Missing U.S. Application Serial Numbers on pages 15 and 22 of specification.
Please Supply.
Thank You
DG

[XRUSH] **RESPONSE:** corrected
pg. 15 10/686508
pg. 22 60/511456

see attachments

INITIALS: A

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preferred for the operation of the EVT in MODE 2, it is not meant to imply that MODE 1 operation of the EVT cannot or does not occur therein. Generally, however, it is preferred to operate in MODE 2 in region 95 because MODE 2 preferably employs gearsets and motor hardware particularly well suited in various aspects (e.g. mass, size, cost, inertial capabilities, etc.) to the high speeds of region 93. A shift into MODE 1 is considered a downshift and is associated with a higher gear ratio in accordance with the relationship of Ni/No. Likewise, a shift into MODE 2 is considered an upshift and is associated with a lower gear ratio in accordance with the relationship of Ni/No. Further details regarding the operation of the exemplary EVT can be found in commonly assigned, co-pending US patent application Serial No. 10-686508 (Attorney Docket No. GP-304193), which is hereby incorporated herein by reference in its entirety.

KH 9-14-05

[0053] The present invention may be described generally as a method of providing closed-loop control of power flowing into and out of an energy storage system (ESS), wherein the ESS comprises a battery. More particularly, it is a method of providing closed-loop control of power flowing into and out of an energy storage system of a hybrid electric vehicle, wherein the ESS comprises a battery pack or array. Most particularly, it is a computer control algorithm for determining the charge and discharge limits for the ESS in a hybrid electric vehicle (HEV), wherein the ESS comprises a battery pack or array.

[0054] In the present invention, certain battery power input and output limits are determined for the ESS such that the battery is protected from damage yet is capable of maximum available utilization within the particular application, such as an HEV. Factors such as extreme state of charge (SOC), voltage, including overvoltage and undervoltage, and current can damage the ESS and thereby reduce its service life. In addition, these parameters are temperature dependent, such that a method for protection and optimization of the ESS and its service life must also take into consideration temperature effects. Further, it is known that the service lives of secondary batteries of the types described herein are related to their cumulative energy throughputs as

[0067] The proportional derivative (PD) controller is used to determine the rate at which the ESS power limit can change. Later, the output of the PD controller is integrated to obtain the overvoltage-based power rate limit, as illustrated in FIG.19. Thus, the proportional term described above actually becomes an integral term and the derivative term described above becomes a proportional term. Therefore, this arrangement actually functions as a PI or IP controller.

[0068] Next, the minimum and maximum values of the charge power integrator are determined as illustrated in FIG. 17. These values are based on the SOC, temperature, and amp-hour throughput. Each of these limits is determined using lookup tables based on the particular parameter. For example, the typical form of the charge limit lookup tables associated with these parameters is shown in FIG. 17. For example, for low SOC values, full charging of the ESS is permitted. As the SOC rises above a breakpoint, the charging power limit is reduced such that additional charging that would continue to increase SOC. The power limit is reduced to limit the system from charging at the highest values in cases of higher than desired SOC. Since the system can easily move from charge to discharge as dictated by drive demand, the limits constrain the use of the batteries. Typically a discharge would occur at some time to bring the SOC down and at the next charge opportunity, the system charging would be limited so the SOC would not increase back to the higher value. If SOC continues to increase past the zero power point, the charging limit would actually change sign such that it would set a limit to force discharging of the ESS. The limits for AH/H throughput and temperature are similarly determined except that they do not change sign to force a discharge. Power in either direction functions to increase temperature and amp-hour per hour (AH/H) throughput. The AH/H throughput may be determined by integrating the battery current using a low pass filter as described in commonly assigned, co-pending US provisional patent application Serial No. 60/571456 Attorney Docket GP-304118, which is hereby incorporated herein by reference in its entirety.

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